

QUARTERLY REPORT

1. **Contract No.:** DAMD17-91-C-1081
2. **Report Date:** 26 February 1993
3. **Reporting Period:** 16 November 1992 through 15 February 1993
4. **Principal Investigator:** Dr. Robert W. Verona
5. **Telephone Number:** (205) 598-6389
6. **Institution:** UES, Inc.
4401 Dayton-Xenia Road
Dayton, Ohio 45432
7. **Project Title:** Development of Data Packages on the Human Visual Response with Electro-Optical Displays.
8. **Current staff, with percent effort of each on project.**

NAME	TITLE	HOURS	% OF EFFORT
Dr. Robert W. Verona	Engineering Psychologist	440	90%
Dr. Victor Klymenko	Research Psychophysicist	448	92%
Mr. Howard H. Beasley	Electronics Technician	467	96%
Mr. John S. Martin	Electro-optics Technician	450	92%

* 488 hours were available this reporting period not including holidays. The above hours are the actual hours worked (sick leave and vacation have been subtracted).

9. **Contract expenditures to date:**

Personnel	\$407,160.22	Equipment & Supplies	\$ 3,661.71
Travel	4,591.30	Other	<u>3,636.88</u>
		TOTAL*	\$419,050.11

* Does not include facilities capital and G&A expense

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10. Comments on administrative and logistical matters.

None.

11. Scientific Progress:

Physical Measurements:

The prototype electro-optical systems that are being characterized contain both image intensifiers (I²s) and cathode ray tubes (CRTs). This quarter's efforts were divided between the I² and CRT characterizations.

This quarter's efforts also investigated the efficacy of using a color television monitor with only the red color channel activated for image intensifier (I²) performance measurements instead of a typical tungsten lamp with a 2856°K color temperature. After proving that the monitor could be used interchangeably with the lamp, the monitor was substituted for the tungsten lamp for some of the psychophysical tests when applicable.

Tests of the gain, field-of-view (FOV), magnification, overall distortion, and subjective resolution were conducted on seven ANVIS, two Honeywell I-Night modules, two Eagle-Eye Night Vision Goggle systems and four ANVIS-oculars. The data and test results were provided to Major Rabin and filed in our data log book. These data and results are also documented on Sigma Plot computer files. Several of these tested systems will be used in the hyperstereo flight test scheduled to begin in March 1993.

In support of and preparation for the flight test, the IHADSS hardware has been reconfigured, hardware modifications have been coordinated with the manufacturer, the IHADSS integrated helmet unit has been interfaced with the Eagle-Eye and ANVIS, and assistance has been provided with the installation of additional IHADSS hardware on the test aircraft.

Another objective of this quarter was the development of a dynamic modulation transfer function (DMTF) measurement capability. The static MTF curve shows the dependent variable as the Michelson or modulation contrast versus the independent variable, spatial frequency. The DMTF is a family of curves showing the modulation contrast versus spatial frequency for a series of drift velocities. The drift velocity for the static case is zero. The drift velocity must be constant for the same range of spatial frequencies as the static case so a curve can be drawn showing the MTF curve for each specific drift velocity.

Significant progress has been made in the DMTF measurement area. Three hurdles were originally in our path. First, the generation of the stimulus waveform required two precision oscillators operating at slightly different frequencies. The difference between the frequencies had to be continuously adjustable so that the pattern generated on the display would drift laterally in

a precisely controlled manner over a full range of spatial frequencies. A circuit was designed and fabricated that would set the spatial frequencies and the drift velocities reliably and accurately.

The second hurdle involved measuring the luminance profile of the sinewave pattern as it drifted across the display face. The maximum and minimum luminance values of the profile are used to calculate the modulation contrast, $M_c = [(L_{\max} - L_{\min}) / (L_{\max} + L_{\min})]$, for each spatial frequency at each drift velocity. The normal photometer electronics did not have an adequate temporal response to collect the luminance data at the required rates. The photomultiplier had to be coupled directly to a high bandwidth storage oscilloscope to capture the luminance profile.

The third hurdle still remains. The measurement process needs to be automated as much as practical. After the manual process is validated the hardware and software will be developed to automate the DMTF measurement process for the miniature CRTs, and possibly the image intensifiers.

Psychophysical Measurements:

This last quarter has primarily been devoted to running subjects under the protocol, "Psychophysical assessment of visual parameters in electro-optical display systems." Eighteen subjects were run in the "luning" experiment (Experiment 2 in the protocol) and the data analyzed. Briefly, this experiment measures the detrimental visual effect known as "luning" under different viewing conditions. The laboratory report for this experiment is in preparation. A protocol amendment for follow-up experiments will be submitted next quarter.

The data from the luning experiment is shown in Figure 1. Each of the data points represent the mean percentage of time luning is seen for a twenty-five second stimulus presentation interval (3 blocks, 18 subjects). The twenty-two experimental conditions are grouped under test factors as follows. The first and most important factor was binocular overlap display mode--convergent versus divergent viewing. The second factor was brightness of the field-of-view (FOV)--dim, medium or bright. The third factor was the effect of adding edges or lines to the binocular border. Kaiser (Melzer and Moffitt, 1991) had tested black versus no lines. In Figure 1, the four data points with asterisks roughly correspond to the four data points in the Kaiser study. We also tested white lines and the effect of dimming and brightening the monocular side regions (third and fourth panels respectively in Figure 1).

Conclusions from this experiment briefly are as follows: In the no lines case, divergent viewing produced significantly more luning than convergent viewing, where background brightness of the FOV had no significant effect. Confirming Kaiser's findings, black lines systematically reduced luning by a roughly equivalent amount in both the divergent and the convergent viewing conditions. For the white lines, there was also a reduction in luning and there was a significant linear trend, where brighter FOVs produced less attenuation of luning due to the lower contrast

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between the white lines and the background. The diamond data points in the fourth panel are reproduced from the first panel. Here it can be seen that changing the brightness of the monocular side regions significantly reduces luning, dimming significantly more so than brightening. This experiment was basically an empirical study, which it is hoped will be followed up in protocol amendments with some more theoretically based studies. Preparation has begun writing the software, designing the experiments, and testing visual displays.

The limits experiment (1A in the protocol), will continue next quarter. It measures visual sensitivity across the visual field under different display modes. While it is still too early to make any firm conclusions, there does seem to be a small effect, where divergent viewing raises the threshold of high spatial frequency stimuli near the binocular/monocular border relative to convergent viewing. It is expected that sufficient data from the limits sessions will soon be collected to permit the start of staircase sessions (experiment 1B in the protocol). The training sessions (contrast matching) have been discontinued as they did not appear to be producing systematic results (i.e., individual differences were masking effects of interest).

With the data from small samples of subjects often unstable (i.e., overly influenced by outlier cases) when analyzed in terms of conventional parametric statistics, newer distribution-free statistical methods for analyzing data are being evaluated.

References

Melzer, J. E. and Moffitt, K. (1991). An ecological approach to partial binocular-overlap. Large Screen Avionic and Helmet-Mounted Displays. SPIE Conf. 1456., San Jose, CA.

12. Milestones:

Review of the draft technical report on the image intensifier measurement procedures has been completed and it will be released as a final report next quarter. The technical report (reprint) of our SPIE paper on CRT measurements is now at the printer.

There is still a need to measure the DMTF of image intensifiers. Consideration is being given to using a miniature CRT as the image source for image intensifier DMTF measurements. Only after data is collected from the miniature CRTs with various phosphors can a prediction be made regarding how adequately they will serve as an image source for the image intensifier DMTFs.

Literature search and software development continue in preparation for further studies and protocol amendments. Preparation of a paper for the Association for Research in Vision and Ophthalmology, and a USAARL laboratory report on the luning experiment are expected next quarter.